TABLE OF CONTENTS

MAIN POINTS OF THE ADVICE

The Commission for Environmental Impact Assessment considers the following points in her advice as crucial for the Andhra Pradesh Groundwater Bore Well Irrigation Scheme project. In the advice the Commission focused on the recommendations for the Inception report.

Review of the Environmental Impact Statement (EIS)

The Commission finds, with reference to the prepared framework (see appendix 4 to this advice), the EIS incomplete and the quality of the presented information insufficient. The following subjects are not described or addressed adequately: the autonomous development, the availability of groundwater, the socioeconomic- and institutional aspects. During the field visit it became clear that the two sites for which pilot studies are done are not representative for the study area.

Recommendations for the Inception report

The Commission is convinced that the impacts of the projected provision of groundwater facilities (drilling of 5400 bore wells by APWell) will be such that water availability in the long term is not guaranteed for a large part of the project area. As a consequence it is feared that the anticipated water scarcity will unequally affect the various social strata present in the area. Therefore, the Commission advises:

- to put more emphasis on recharge improving measures and installation of water users organisations by means of adopting a watershed management approach.

This approach is assumed to be well known. Therefore, components of this approach are only elaborated if they are related to the APWell project.

The following recommendations are not related to watershed management exclusively.

1. Site selection

Site selection for bore well clusters should concentrate on:

- micro-catchments in which no or little groundwater development has been done so far;
- micro-catchments with good potential for artificial recharge through watershed management; no adverse impact on land under forest may occur;
- presence of the target groups who have no possibilities to develop groundwater resources; scheduled castes, scheduled tribes and backward classes should be considered with priority in the given order;
- micro-catchments in which farmers and/or Governmental organisations (GOs)/Non Governmental Organisations (NGOs) started with watershed management.

2. Implementation of bore wells at site level

Physical environment
The availability of groundwater is a condition for further agricultural development. Sustained use of groundwater should be achieved by the preparation of a plan for integrated and comprehensive water development. Considerable regional variations in catchment water budgets should be taken into account.

Socioeconomic environment
To ensure a sustained use of and access to groundwater APWell should concentrate on:
- Participation of the people concerned.
- Application of the following measures: improving recharge and efficiency of water use, and sustainable agricultural practices.
- Gender issues during all stages of implementation, ensuring participation of women.
- Prudent consideration of the relation between access to groundwater and land ownership. (Women's ownership should be emphasized in case of government assigned lands.) Female headed households and farm households jointly owning the land should be considered with priority.

Institutional environment
To ensure a sustained use of, and access to groundwater APWell should concentrate on:
- Participatory planning by the beneficiary and non-beneficiary farmers.
- Development of watershed management committees and informal bore well users groups; these groups should be represented in the committees.
- Training of male and female farmers by extension in order to improve the effective use of groundwater and to avoid groundwater contamination.
- Set up of a monitoring and evaluation system.
- The present "mining" of groundwater underlines the need of implementation legislation on groundwater utilization in Andhra Pradesh.

The watershed management approach should be elaborated for each district. The District Collector has a crucial role to play as he has the opportunity to stimulate and coordinate cooperation between the various departments involved, making an integrated approach successful.

1. INTRODUCTION

1.1 The initiative: Realization of groundwater bore well irrigation schemes in Andhra Pradesh, India

The government of India intends to construct 5400 groundwater bore well irrigation schemes covering a total net area of 16,200 hectares, in seven districts in Andhra Pradesh, India. The project is known as the APWell project (APWell). The government of the Netherlands has been requested to provide funding for this initiative. In July 1994 this request was approved by the Netherlands Minister for Development Cooperation.

Objectives of the project:

- The main objective is to increase agricultural production of small and marginal farmers in a number of districts in Andhra Pradesh through the provision of groundwater irrigation facilities.
- The long-term objective is to improve the living conditions of the small and marginal farmers in the project area. This will be achieved through sustainable (environmentally sound) interventions, in such a way that both men and women can obtain equal conditions and opportunities in agricultural and other activities.

Project area:
The project aims at those districts on hard rock in which groundwater can be used for irrigation. Seven districts in Andhra Pradesh have been selected according to a priority index issued by the State Finance and Planning Department. The following issues are considered in this index:

- non-irrigated cropped areas;
- geographical area of drought prone sub-districts;
- tribal population and number of small and marginal farmers;
- operational convenience of Andhra Pradesh State Irrigation Development Corporation (APSIDC, the developer of the project).

The districts, all situated in the central and southwestern part of the State, are selected on the basis of the index (see appendix 7 for map of Andhra Pradesh):

1. Kurnool
2. Mahbubnagar
3. Anantapur
4. Prakasam
5. Nalgonda
6. Chittoor
7. Cuddapah

1.2 Motive for and objectives of this review advice

In a letter dated 6 April 1995 the Minister for Development Cooperation in the Netherlands has invited the independent Commission for Environmental Impact Assessment in the Netherlands to perform an advisory review of the Environmental Impact Assessment (EIA[1]) and to formulate recommendations concerning the execution of APWell (appendix 1). Funding of the project was approved by the Minister in July 1994 and started the 1th of April 1995 with an inception phase, for a period of five months. The aim is to include the results of the review and recommendations in the inception report. The inception report will be available in September 1995.

Objectives of this advice are:

- review of the Environmental Impact Statement (EIS);
- recommendations concerning the execution of the project focusing on: criteria for site selection, sustainable use of groundwater and monitoring and evaluation.

This advice has been prepared by a working group of the Commission. The composition of this working group is presented in appendix 2. The group represents the Commission and will therefore be referred to as 'the Commission'. In the Commission the following disciplines are represented: geohydrology, civil engineering (irrigation), agriculture, agronomy, rural sociology (gender), institutional aspects, resource management and health.

The Commission visited India in the period 6 – 15 June 1995. The objective of the visit was to check the information as presented in the EIS and gathering of additional information to enable specific recommendations. The working programme is presented in appendix 3.

Herewith the Commission wishes to express gratitude for the excellent support and courtesy extended to the Commission by the Irrigation Development Cooperative in Hyderabad, the staff of the APWell project, all Indian parties contacted and by the Royal Netherlands Embassy in Delhi during her visit.

1 Environmental Impact Assessment. Andhra Pradesh Ground Water Bore Well Irrigation Schemes. APWell Project. prepared by: Administrative Staff College of India. Hyderabad, April 1994.

1.3 Justification of the approach

The Terms of Reference (ToR)[2] which served as a basis for the preparation of the EIS do not cover adequately the subjects which need to be addressed in the EIS according to the request by the Minister for Development Cooperation. The following subjects are not described or addressed adequately: alternatives at site level, the autonomous development, and the socioeconomic and institutional aspects.

Therefore, the Commission prepared her own framework for the review of the EIS, which is presented in appendix 4. In the preparation of the review framework, use is made of the Terms of Reference. Furthermore, during the field visit it became clear that the two sites for which pilot studies are done are not representative for the study area.

In chapter 2 the main findings of the Commission are presented concerning the review of the EIS. Recommendations for the inception report are elaborated in chapter 3.

1.4 Limitations encountered

The Commission has not been involved in the scoping and formulation of the specific project guidelines that resulted in the ToR. As there was no formal agreement between the Commission and the Directorate General for International Cooperation of the Ministry for Foreign Affairs (DGIS) during the time the ToR were made. Despite this fact she appreciates the opportunity given by DGIS to prepare this advice.

[2]
- Terms of Reference for the Environmental Impact Statement. Appendix 4. In: Project document. Andhra Pradesh Ground Water Minor Irrigation Schemes. Andhra Pradesh State Irrigation Development Corporation & Directorate General for International Cooperation. March 1992.
- Checklist of environmental parameters for projects in irrigation. pp. 15-16. In: Environmental guidelines for selected agricultural and natural resources development projects. Asian Development Bank, 1991.

2. MAIN POINTS OF THE REVIEW OF THE EIS

2.1 General conclusion

As stated before the review of the EIS is limited to main points. The framework prepared by the Commission (see appendix 4), is used for the review.

The Commission appreciates the idea of executing well clusters instead of individual wells as worked out in the EIS. Despite the limited time available to prepare an EIS a lot of information was gathered. Furthermore, she appreciates the fact that an EIA was executed.

However, the Commission finds the EIS incomplete and the quality of the presented information insufficient. The following subjects are not described or addressed adequately: the autonomous development, the availability of groundwater and socioeconomic and institutional aspects. During the field visit it became clear that the two pilot studies are not representative for the study area as well.

2.2 Review of the EIS

Site selection for bore well clusters

- Criteria for the selection of sites for bore well clusters and individual bore wells are not clearly specified. Some criteria are mentioned, but not elaborated and scattered throughout the text. In addition, the procedures for site selection which are mentioned are general and incomplete.
- There could well be an inverse relationship between the relative 'backwardness' of the areas or subcatchments selected and the general availability of groundwater. *(It is less risky to explore areas with known groundwater, as evidenced by existing good wells.*) Therefore, the a priori site selection may require more analysis of existing data and validating data to become available during the project, than is mentioned.
- Before selecting a specific cluster site, information should be gathered on the local effects on groundwater as a result of the installation of the bore well cluster. Not only the annual balance of withdrawal and recharge should be reviewed, but also short term effects. The effects on domestic water supply should have been assessed.
- The EIS approach to select two districts and in these districts two pilot clusters – more or less representative for the project – which were described in detail, is acknowledged. This approach was chosen because not all prospective clusters can be described in such detail. In adopting this approach, however, it is necessary to indicate how the judgement of the environmental impact of the establishment of other clusters should be extrapolated in a practical way. This aspect is missing.

Selection of the two pilot clusters

- The EIS does not indicate well why Appaipally village in Mahbubnagar District and Khambampadu village in Prakasam District have been selected for the development of bore well clusters, and how the number of prospected bore wells was determined (Appaipally 200 and Khambampadu 20).
- There is no agreement between APSIDC and Andhra Pradesh Remote Sensing Application Centre (APRSAC) on the possibility to develop a cluster of 200 bore wells in Appaipally village. The EIS states that calculations indicate that possibly 40 bore wells may be installed without risks of over-pumping the area. It remains unclear in the EIS whether, and if so, how many bore wells can be established in this pilot cluster.

- ! The above uncertainty concerns a basic question for the site selection of a cluster site. It would have enhanced the strength of the EIS if this issue had been elaborated in detail, including suggestions how to improve on groundwater assessment procedures and methods on behalf of future clusters for which no detailed EIS will be made.
- ! Based on two pilot EISs it is not possible to judge whether the proposed activities at these two sites will be sustainable (ecologically as well as socioeconomically).

Physical environment

- ! The basis for the availability of groundwater is the Mandal-wise assessment of groundwater potential by the AP State Groundwater Department. Criterion is the classification per Mandal into either 'white', 'grey' or 'black' areas. However, the classifications have to take into account the environmental factors influencing the recharge conditions, which differ widely according to the varied hydrotopes of the districts concerned. Continuous updating and refinement of the classification are required, whereby the results of ongoing monitoring and evaluation efforts should be used
- ! Assessment of ongoing groundwater extraction in the study area (private or public) is lacking.

Socioeconomic environment

- ! Although socioeconomic aspects are described in the EIS, this is not done consistently. A major omission is the lack of differentiation between socioeconomic groups and between men and women, although both are mentioned explicitly as target group in the data collection and analysis.
- ! A gender perspective is lacking. For example, gender/women's issues are addressed under food habits and impacts of pesticides, while it will be clear that the health of women will be affected (agricultural labourers are often women, traditional food habits). The time allocation for productive and reproductive tasks carried out by women will change due to changes in crops and food habits. The EIS does not indicate to which extent and how women will be included in documentation of indigenous traditional knowledge.
- ! Concerning procedures in groundwater development, the EIS does not clarify: criteria and conditions for application (page 64, 65); who will have access to and control over bore wells; which socioeconomic categories differentiated into men and women will benefit and will not benefit; which specific constraints will be met by the target group (different categories of small and marginal male and female farmers) in order to ensure their access to and control over water/bore wells.
- ! Related to health, the following comments have to be made:
  - The text suggests that the malaria vector thrives in dense forest. According to the Malaria Research Centre in Delhi, the principal malaria vectors in the region appear to be *Anopheles stephensi* and *Anopheles culicifacies*. The first breeds in places such as wells, artificial containers, ponds et cetera. The second in e.g. borrowpits, irrigation channels and rice fields. In other words, contrary to what is suggested in the EIS, the principal malaria vectors in the region probably do not depend on dense forest, but rather on the type of habitats that are likely to be expanded as a result of the project activities.
  - The diseases *filariasis* and *Japanese encephahilites* are specifically mentioned in the ToR on basis of which the EIS is prepared but they are not considered in the EIS.
  - In Mahbubnagar district, only positive (favourable) health impacts are expected. § 12.4.1. (page 131) states: "Irrigated agriculture would also result in higher production and incomes, thereby nutritional levels will increase improving the health status". However, experience in Asia and Africa indicates that malnutrition may increase after introduction/expansion of irrigation when the irrigated cash crop reduces the resources available for food crops and vegetables cultivated for domestic consumption.
  - § 12.4.2 describes adverse impacts in the Prakasam district, due to (i) (ground)water quality, and (ii) high levels of inorganic fertilizers and pesticides used in cotton cultivation. The section advocates a strict vigil on water quality during the first three years of the project and gives an extensive list of precautions intended for operators handling pesticides. However, it does not

indicate who will be responsible for monitoring and for conveying these precautions to the operators. Information on how the health risks will be taken into consideration is lacking.

Institutional environment

- The institutional aspects of the project are insufficiently described and elaborated in the EIS. A number of institutions and organizations are mentioned, but in the last chapter no indication is given which institution(s) should carry out the recommendations. Also matters of cooperation and coordination between the different implementing GOs and NGOs are not addressed.
- The information and guidance of water users groups is essential, and will be one of the major subjects of the project intervention. The subject of the organisation of water users and their participation in area selection, design and management is rather new in India and experiences are still limited. Moreover, the sheer number of prospected bore wells and thus the number of water users groups in the project will increase the complexity of this project element. The EIS acknowledges the important role which NGOs will play in the project in this respect, but discusses the subject only in general terms.

3. RECOMMENDATIONS FOR THE INCEPTION REPORT

Recommendations presented in this chapter refer to aspects which are not, or insufficiently elaborated in the APWell project documentation. These recommendations are made for two different steps in the execution of the project:

- selection of sites for the installation of bore well clusters for the study area (§ 3.2);
- implementation of bore wells if a site is selected at local (watershed) level (§ 3.3).

In appendix 5 (technical) remarks are made to underline and substantiate the recommendations as presented in chapter 3. These are primarily based on observations made during the visit of the Commission to Andhra Pradesh.

3.1 Introduction

In order to ensure the groundwater availability in the long term the Commission advises to adopt a watershed management approach. It is assumed that this approach is well known. Therefore, components of this approach will only be elaborated in this chapter if they are related to the proposed project. The following components are worked out:

- measures to improve recharge;
- installation of water users organisations.

The well yield can become sustainable at a higher level by adequate application of these components. Other recommendations elaborated are not related to watershed management exclusively.

3.2 Site selection

Main criteria

Obviously, the availability of sufficient groundwater is a precondition for any groundwater development. Master plans for integrated and comprehensive water development should be prepared for each district. Further, the site selection of the well clusters should concentrate on:

- micro-catchments in which no or little groundwater development has been done so far;
- micro-catchments with good potential for artificial recharge through watershed management in micro-catchments, to be executed by the community (no adverse impact on land under forest may occur);
- target groups who have no possibilities to develop groundwater resources; scheduled castes, scheduled tribes and backward classes should be considered with priority;
- micro-catchments in which farmers and/or GOs/NGOs started with watershed management.

There is no competition between areas with natural value (biological diversity) and potential areas for installation of bore wells because these areas hardly interfere. If they do interfere land under forest should be excluded from site selection.

Considering the target group, women's land ownership is a selection criterion. Furthermore, female headed households that have man and women's joint ownership should have priority. Other elements for consideration are: topography; soil conditions; electricity supply; accessibility of the area; opportunities for trickle irrigation and possible other available sources of irrigation supply, notably public canal systems and tanks.

Clustering of bore wells

The advantages of the projects approach of clustering bore wells dominates and should be followed. However, flexibility should be practised and in contravention of the rule:

- promising opportunities for single bore wells should be honoured where possible.

One or two clusters of bore wells should be established in Nalgonda district, after the groundwater management plan will have been prepared. This will serve as a pilot activity which indicates how bore well selection can be based on a larger scale groundwater management plan.

Field visit/groundwater development reports
To include the environmental aspects of the installation of a cluster of bore wells thoroughly the Commission advises to prepare a field visit/groundwater development report. Such a report should be prepared for each site selected and should be based on a comprehensive field visit and a short desk study, particularly on the availability of groundwater. The guidelines as presented in appendix 4 could be used as a checklist. This report should be used as an input at the start of the process of participatory planning with the farmers.

3.3 Implementation at site level

3.3.1 Physical environment

Groundwater availability
In view of the main findings of the Commission, a strong and concerted effort should be made to plan for and implement sustained use of the groundwater resources by the APWell project. This may be achieved by:

- Preparation of master plans for integrated and comprehensive water development in the districts. A functional hydrogeological differentiation of the districts concerned should be prepared, which also plays a central role in the monitoring, see § 3.4 for data collection.
- Close coordination with the current programmes of watershed management in order to bring about sustained use of groundwater, i.e. withdrawal should not exceed recharge; stimulation of recharge facilities.
- Raising the awareness of the farming community and the authorities aiming at the prevention of adverse events taking place (depletion of groundwater).
- Stimulate and support the efforts made for introduction of new legislation, because existing legislation is lacking.

The target size of 3 hectares irrigated land per well is only a crude average; negative or positive deviations from this average should be anticipated and accepted. The Commission is of the opinion that the target size of 3 hectares should be assumed as a maximum which may be achieved if recharge and water efficiency improving measures are executed.

The fluoride content of all production wells should be tested, because fluoride hazard may be present in nearly all hydrogeologic regions, with the exception of the areas where quartzites dominate.

3.3.2 Socioeconomic environment

Participation and farmers' (women) needs
A systematic effort must be made to design a gender-specific strategy which actually addresses gender issues at various stages of the scheme implementation and ensures effective participation of small and marginal farmers (including women). To ensure womens' participation and needs in the planning process, a list of remarks is made, see appendix 5, § 2.2.1 and 2.2.2).

Land ownership
Since women's ownership is a selection criterion, as defined in the project document, assistance has to be given by the local NGO in transferring the ownership of government assigned land to women. Access to irrigation is related to ownership of land. The policy of the government of Andhra Pradesh is to give government assigned land to women (see § 2.2.3 and appendix 6). However, in practice mainly men receive ownership.

Irrigation efficiency

The following practices will increase the efficiency of water use:

- Lining of distribution channels or the application of subsurface pvc pipelines with an outlet for each farmer would reduce water losses, which are relatively high due to the very small flows concerned. Both channel lining and subsurface pvc pipes have their distinct advantages and disadvantages. It is proposed to explain pros and cons to the concerned farmers and leave the choice to them.
- A higher priority should be attributed to land levelling and bunding of fields. Land levelling and bunding within the bore well commands would increase the effectiveness of irrigation and the contribution of rainfall to crop water requirements considerably, and is recommended where not yet carried out.
- Improvement of land levelling should be an integral element of scheme development. Since land levelling involves relatively high costs, considering the income position of small and marginal farmers, a contribution of the project to land levelling is expected to increase interest among farmers.
- The project could identify bore well locations on the additional criterion that trickle irrigation will also be applied.

Sustainable agriculture

Sustainable (irrigated) agricultural practices should be applied to guarantee the productivity of the land, the health situation of the farmers, and to avoid soil erosion and pollution of soil and groundwater in the long term. On request of the APWell project staff examples of these practices are presented in appendix 5, § 2.2.6.

3.3.3 Institutional environment

Recharge improving measures.

To improve the recharge of the groundwater directly, all kinds of physical works can be prepared. These works have to be situated where the effect of infiltration is maximal. These sites are often located on hillsides or in riverbeds and are not owned by the farmers who are benefitting from these recharge measures through higher water yields. To enable the preparation of recharge measures commitment of the owners of these sites (often non-beneficiaries) is necessary. Therefore, the different owners of land and users of water should prepare a plan at the watershed level to ensure the involvement of all farmers and owners concerned. A Watershed Committee should be installed to deal with such a plan.

Furthermore, measures could be implemented contributing to recharge improvement indirectly, like reforestation and management of common lands.

Water users groups

To ensure sustained groundwater availability and the effective participation of farmers, water users groups should be installed. These organisations become responsible for control of groundwater use and distribution. The following organisations with different aims can be distinguished:

- At the individual bore well level, Informal Bore well Users Groups should be installed. The membership of these groups should consist of men and women farmers using water from one bore well. These groups should not be registered officially and be represented in the watershed association and committee.
- At the Watershed level, a Watershed Association and a Village Watershed Development Committee should be installed. In this organisation beneficiary (groundwater users) and non-

beneficiary households should be represented and special attention should be given to the representation of women from small and marginal farm households and the landless labourers. To enable female farmers to voice their concerns and allow them an active role in decision making processes and to participate in non-stereotype roles, their participation should be ensured in the overall analysis, planning and decision making regarding the development of the watershed and the bore wells. Their training should be organized by the NGOs.

Electricity

- Before taking up the development of a cluster of bore wells, commitment of Andhra Pradesh State Electricity Board (APSEB) should be assured on the time span within which electricity connection to the grid is guaranteed, the available capacity of the grid and on the minimum, maximum and average daily hours of electricity supply.
- It is imperative for the successful operation and maintenance (O&M) of the bore well by farmers, that the quality of the electrical equipment and its installation is optimal. Special care should be given by the project to this point.

Training and extension

- As the bore wells will be privatised and will be completely managed by the farmers after one year, training must be given to the bore well water users groups to be self-supporting in handling conflicts arising from sharing water, collecting water tariffs, keeping accounts and in O&M. The local NGOs could play a role in organizing bore well water users groups as they work closely with the farmers and know their target group well. The technical training for O&M shall be organized by APSIDC for male and female farmers.
- Training in sustainable agricultural practices for the farmers and field staff of governmental organisations (GOs) and NGOs is necessary. Train assistance could be asked from the Dutch assisted project Agriculture, Man and Ecology at Bangalore.
- NGOs should provide information on loan and credit facilities that could be practically accessible to farmers. Farm women should be organized and trained to make productive use of their increased income. They should be organized to form self-help groups by developing, saving and thrift habits.
- Women's participation in irrigation projects does not come by itself, it has to be facilitated. NGOs involved in farmers organizations need to develop a special strategy to reach women.

Institutional linkages

The District Collectors coordinate various governmental programmes and they could play an important role to link the project with specific watershed management programmes, like: the Drought Prone Areas Programme (DPAP) of the government of Andhra Pradesh, the United Nations Development Programme (UNDP) and other government schemes like Integrated Rural Development Programme (IRDP), Development of Women and Children in Rural Areas, Andhra Pradesh Training of Women in Agriculture (APTWA) and Mahila Samatha.

Institutional capacities and roles expected of implementing organizations

- A sound institutional framework with clear responsibilities needs to be worked out for smooth collaboration between APSIDC, the NGOs and the Netherlands Assisted Programme (NAP).
- NAP should make a careful assessment of NGOs existing training capacities and of needs for strengthening such capacities.
- NGOs should recruit female field staff for training in the context of this programme.
- It is therefore recommended that the project should start with participation in general and women's participation in particular in a smaller number of bore wells on a pilot basis. The tangible

results can be expected for these bore wells and these results should serve as positive examples for other sites.

3.4 Monitoring and evaluation

Monitoring and evaluation should be executed to control if the project objectives as mentioned in § 1.1 will be realized. Two steps should be distinguished:

- the site selection;
- the implementation of a cluster of bore wells at a selected site.

Information of sufficient quality and depth to assess the hydrogeological situation is not available. This will hamper the planning of the sustained use of the groundwater resource by the project. The interrelated components which should receive attention are:

- Hydrogeological differentiation by a mapping and description of 'hydrotopes'.
- Establishment of a monitoring system, in close coordination with an independent organization, such as the regional Office of the Central Groundwater Board (CGWB).
- Analysis of the data for proper recharge estimation (effects of watershed management), coupled to socioeconomic data/indicators pertaining to the target group participating in the well cluster programme.

These efforts are indispensable for the development of the Master Plan for the utilization of the water resources in the districts.

The expertise for the planning and monitoring function is largely available in India, but requires linkages of the Institutions involved and a training programme geared towards the above mentioned fields of attention. The technical assistance unit of IDC could have a coordinating role, but the status of the cooperation should be institutionalized by authorities such as the (Principal) Secretary Irrigation of the AP Ministry of Irrigation.

Overview

More attention should be paid to the hydrogeologic differentiation of the districts because of the large variations of associations of lithology, geomorphology, soils and land cover (i.e. hydrotopes). The necessary technical expertise is available in India, but could be supplemented by the technical assistance and the training programme. This overview should consist of a 'hydrotope map' at 1:250.000 scale, which serves as the basis for the planning and monitoring.

Monitoring function

An independent organization, such as the CGWB, through its Regional Office in Hydrabad, should provide the leadership in the groundwater monitoring. (A new monitoring programme with World Bank assistance will start soon; about 200 wells in Andhra Pradesh will be equipped with automatic gauges). The APWell project may initiate and stimulate the incorporation of socioeconomic data and performance indicators in the monitoring programme, not only technically (data base) but also in the domain of institutional linkages.

Monitoring setup

There are three interrelated components (A, B and C);

A. Technical
   - The comprehensive data base (hydrogeologic and socioeconomic data using e.g. relational data base management system).
   - Geographic Information System (GIS) and Remote Sensing (RS).
   - Spreadsheet operations and graphics.
B. Establishment of procedures to transform *data* into *information* required for the monitoring.
C. Feedback mechanisms; adjustments to the planning and field actions.

Geophysics
The additional value of application of geophysics is limited, with respect to the experience of the hydrogeologists in the ADSIDC/APWell project on the one hand and the costs on the other hand. Therefore, geophysics should be applied only on:

- Areas, where because of the criteria for site selection for the wellclusters, the success percentage of good wells will fall below mentioned targets, while the well cluster concept should be maintained (many wells in a cluster may have low yields).
- Location of high yielding wells, because these have generally larger recharge areas, hence the effects of watershed management will be increased.
- Locations where the concept of several farming families working together may be difficult in view of expected low yields per well.

Socioeconomic data
A base line study to identify priority targets groups and relevant village level institutions should be undertaken by the NGO field staff, using the Rapid Rural Appraisal techniques. Baseline information should include village socioeconomic profiles, cropping patterns, gender division of labour, household economy, access to institutions and priority needs of men and women.

A positive impact of irrigated agricultural practice is increased income. However, increased income does not automatically lead to increases in well being of all family members. It is recommended to develop a number of qualitative indicators to measure the improvements in living conditions, including the health situation (see appendix 5, § 3.5).